(12) UK Patent Application (19) GB (11) 2 360 690 (13) A

(43) Date of A Publication 03.10.2001

(21) Application No 0007746.1

(22) Date of Filing 30.03.2000

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(51) INT CL[7]
A23B 4/06

(52) UK CL (Edition S)
A2D DEF

(56) Documents Cited
EP 0245033 A1 JP 010020054 A

(58) Field of Search
UK CL (Edition S) A2B BMM39 , A2D DEF
INT CL[7] A23B 4/06 4/07
Online: EPODOC, WPI, JAPIO

(54) Abstract Title
Slicing frozen meat or fish

(57) A method of slicing a cryogenically frozen block of meat or fish comprises initially cryogenically freezing the block, tempering the block to a predetermined cutting temperature which is lower than the degradation temperature of the block, slicing the block into slices with a slicing machine whilst maintaining its temperature below the degradation temperature and then cryogenically refreezing the sliced material. The method is suitable for tuna, and liquid nitrogen can be used for the initial cryogenic freezing. The cutting temperature is preferably 2-10 degrees lower than the degradation temperature of the block. The slicing machine may itself be temperature controlled.

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The claims were filed later than the filing date but within the period prescribed by Rule 25(1) of the Patents Rules 1995.

METHODS AND APPARATUS FOR PREPARING SLICED FISH OR MEAT

This invention relates to methods and apparatus for preparing sliced fish or meat. The invention is particularly relevant in the preparation of sliced fish for eating raw (e.g. as sashimi or on sushi) although it is not necessarily limited to that. It has particular relevance for fish/meat that is liable to discoloration at ambient conditions and/or which needs to be stored or transported for substantial periods for consumption e.g. because of importation.

BACKGROUND

The background of the invention is now explained in relation to the importation of tuna into the United Kingdom for use among other things in sushi. This exemplifies a challenging situation in conventional practices, since tuna is

- a large fish, and hence difficult to slice finely;
- exotic, and has to be carried a long distance from catching to consumption, and
- particularly prone to discoloration under normal storage conditions, including standard deep freezes.

According to a preferred known practice (which may also be used with tuna or other fish in the present proposals) fresh, wild-caught fish is kept whole (apart from gilling and gutting) on ice/water until ready for transport, whereupon it is filleted and the fillets promptly vacuum-wrapped to minimize exposure to the air which is a cause of discoloration.

Conventionally, imported tuna has been deep frozen in conventional cool rooms i.e. at about -20°C. This is not only for preservation, but also because fresh tuna

cannot easily be cut into the small, thin slices used for sushi/sashimi without disintegrating. It needs the support or rigidity provided by a semi-frozen condition.

Generally a fillet (loin) of fish is hand-cut to form a regular ingot or block, sometimes called a sako block. This is the block that is cut, conventionally by hand using a knife, into the desired small slices after allowing its temperature to rise to near freezing point (0°C).

Unfortunately even at -20°C tuna gradually discolors, changing from pink to brown. Currently this discoloration can be inhibited by additives such as ascorbic acid, but of course it would be preferred to avoid these. Furthermore, during the hand-slicing operation the temperature inevitably rises and if there is any delay a colour change cannot then be avoided. There are therefore many rejects because for commercial (supermarket) sushi the fish needs to be frozen again and kept for perhaps two weeks until used. So, even with the use of additives there is a high reject rate and the slicing is laborious.

In Japan there exists an alternative technique in which the freshly-caught fish after gilling and gutting are immediately frozen in liquid nitrogen on the fishing boat to core temperatures of -60°C and below. Under these cryogenic conditions colour does not deteriorate on storage. Once delivered, the fish is "slacked" (thawed), cut to sako blocks and hand-sliced without additives, since because of the high demand it can be used straight away.

<u>THE INVENTION</u>

It would be desirable to provide new methods and

apparatus for preparing sliced fish or sliced meat, which would enable one or more of these existing difficulties of laborious preparation, discoloration and additive use to be avoided.

What we propose is a method of preparing fish or meat which includes slicing a block of the fish or meat into multiple slices, and which is characterized in that the block, initially cryogenically frozen, is tempered to a predetermined cutting temperature which is lower than a degradation temperature predetermined for the material, and then sliced by a slicing machine while maintaining its temperature below the degradation temperature; the sliced material is then re-frozen cryogenically without its temperature having risen above the degradation temperature.

The re-frozen slices are preferably then packaged directly before cryogenic storage or despatch (which may be cryogenically, or conventionally refrigerated).

The tempering procedure typically provides for an equalisation of temperature throughout the block at the selected cutting temperature. Conveniently this is by keeping the block for a prolonged period of refrigeration. The period will depend on the initial size, material and temperature of the block but typically is at least 3 or 6 and most preferably at least 12 hours, in a tempering chamber maintained at the selected cutting temperature.

The degradation temperature may be selected empirically in relation to a given material according to its chemical nature, its consistency and the kind of degradation which is to be avoided. Essentially it represents a temperature which, if exceeded by the

material during the slicing procedure, will cause a specified deterioration such as discoloration despite the subsequent cryogenic re-freezing of the product. For all relevant products it will be a temperature below room/ambient temperature, usually below -5°C and especially below 0°C. In relation to tuna discoloration we have determined that -1°C represents an important temperature ceiling during such processing.

The cutting temperature achieved by the tempering is selected to be sufficiently high that the product is conveniently able to be sliced by a suitable automatic, semi-automatic or hand-operated cutting machine, while being sufficiently far below the degradation temperature that heat generated in the material by the energy of the cutting operation does not cause the material to exceed the degradation temperature. Preferably this tempered cutting temperature is from 2 to 10C° lower than the predetermined degradation temperature. In relation to fish such as tuna, we particularly prefer a tempering/cutting temperature between -2°C and -8°C, e.g. -6°C.

Again, a skilled person will appreciate that empirical testing may be used to optimise the temperature gap between the tempering temperature and the processing temperature ceiling (degradation temperature). It may be affected by the thickness of the slices. For fish such as tuna, our figures specified are suitable e.g. for standard-size sushi slices which are typically 3 to 4 mm thick and with a target weight of 10g.

Preferably the cutting machine is temperature-controlled in order to maximise control over the temperature change on cutting.

Preferably the cryogenic freezing is at a temperature at which degradation of the relevant kind (e.g. discoloration) does not take place even on prolonged storage. It may generally be e.g. -30°C or below. In the particular case of tuna it has been found that the cryogenic freezing should be at -49°C or colder. Maintained cryogenic freezing (e.g. for the initial block, and the eventual slices) preferably uses liquid nitrogen since this is readily available.

In-process cryogenic freezing may be done batch-wise by dipping in liquid nitrogen or, more preferably, dynamically by passing the product slices along a cryogenic freezing line, e.g. a tunnel having a conveyor which carries the sliced material past sprays or other arrangements for surface contact with cryogenic material such as nitrogen. This latter option enables a continuous processing, e.g. in which the sliced material emerging cryogenically frozen from the line can be packaged in its cryogenically frozen state for cryogenic storage or for despatch.

In another aspect the invention provides an installation for preparing sliced fish or meat materials, including a temperature-controlled tempering chamber set for the above-mentioned cutting temperature, a temperature-controlled cutting machine for slicing material received from the tempering chamber, and a cryogenic freezing arrangement, such as a batch freezer or a continuous freezing conveyor as suggested above, for cryogenically freezing the sliced material from the cutting machine within a predetermined time. Preferably it also includes a packaging machine downstream of the cryogenic freezing arrangement. Other preferred or

optional features of the installation and apparatus appear from the method description above, as do suitable operating temperatures and temperature differences which the system may be adapted or programmed to maintain. A preferred additional facility is a cryogenic storage chamber for uncut block material awaiting processing and/or cut (and preferably packaged) sliced material after processing.

In another respect, the method steps of cryogenic freezing, tempering, cutting by machine and cryogenic re-freezing provide a novel and hygienic method of preparation use for fish/meat that is not subject to any particular kind of short-term degradation. Salmon, for example, is not prone to discoloration. In these cases a degradation temperature need not be determined.

The invention is now illustrated by way of example with a description of processing tuna.

Vacuum-packed tuna loins are received (e.g. from importation as described above under BACKGROUND) at a chiller temperature of 0°C to 4°C.

In a second stage, this material is unpacked for re-dressing, i.e. the removal of superfluous liquid, and congealed blood, and for trimming.

Maintaining the raw material at ice temperature, the loins are cut by hand to ingots (sako blocks) which are roughly rectangular blocks dimensioned to be sliced into conventional slices for sushi. Desirably a slice is 3 to 4mm thick, about $200mm^2$ and about 10g in weight.

It should be noted that no colour-retaining or antioxidant additive such as ascorbic acid is used in the procedure.

The cut ingots are vacuum-packed and passed along a

cryogenic tunnel. This is an enclosed pathway containing a conveyor belt carrying the ingots through sprays of liquid nitrogen, which expose them to a surface temperature in the range -120°C to -135° for a period of 12 to 15 minutes. This treatment equalizes the body or core temperature in the ingots to below -49°C, typically 60°C to -80°C, at which they do not undergo discoloration even on prolonged storage; microflora are either killed or their activity fully suspended.

The cryogenic tunnel is not essential; the ingots can alternatively be frozen in a cryocell to achieve a corresponding core temperature. Treatment in a cryocell might typically be at a surface temperature of -80°C to -90°C for a 40 to 60 minute period.

According to demand, ingots are then withdrawn from cryogenic storage at an appropriate time for processing. This involves transferring the ingots to a tempering room, maintained by conventional refrigeration techniques at a tempering temperature typically in the range -2°C to -8°C, more preferably -5°C to -7°C. -6°C is a preferred temperature for tuna. To equalize the core temperature throughout the ingots with the tempering temperature, they are kept in the tempering room for a period of at least 12 hours, typically from 12 to 24 hours.

Once tempered, the ingots have a consistency suitable for slicing. The ingots at the tempered temperature (-6°C) pass directly to an automatic slicing machine, maintained at a constant temperature, which cuts each ingot simultaneously into a set of slices each with a target weight of 10g ± 2g. The cutting operation inevitably raises the temperature of the slices. We have found however that if the product temperature is

scrupulously prevented from rising above -1°C, the product is protected against subsequent degradation and in particular discoloration. The -6°C cutting temperature is selected to combine convenient cutting and timing with confidence that the product temperature will not rise to above -1°C. Typically it rises to -3 or -4°C.

The cutting machine may in itself be substantially conventional engineering, with a temperature-controlled environment. It may be hand-fed with ingots by an operator. The machine is adapted to lay cut product slices in pairs on a conveyor. This conveyor passes into a cryogenic tunnel in which, by virtue of sprays of liquid nitrogen, the slices are exposed to a surface temperature of -100°C to -120°C for a period of 5 to 7 minutes. The exit temperature of the slices is once again below -49°C, e.g. around -60°C.

The frozen slices are packaged directly on issue from the cryogenic tunnel, either interleaved on trays, vacuum packed, or in loose or pillow packs. The particular mode of packaging is not crucial, since the cryogenically-frozen product is not vulnerable to deterioration at this stage. It may be returned to cryogenic storage, or to a despatch store at a conventional deep-freeze temperature e.g. -15 to -25°C.

CLAIMS

1. A method of preparing fish or meat which includes slicing a block of the fish or meat into multiple slices, and which is characterized in that the block, initially cryogenically frozen, is tempered to a predetermined cutting temperature which is lower than a degradation temperature predetermined for the material, sliced by a slicing machine while maintaining its temperature below the degradation temperatures and the sliced material re-frozen cryogenically without its temperature having risen above the degradation temperature.

2. A method of claim 1 wherein the tempering procedure equalises temperature throughout the block to the predetermined cutting temperature.

3. A method of claim 1 or 2 wherein the block is tempered to the predetermined cutting temperature by keeping the block in a tempering chamber, maintained at the cutting temperature, for a period of at least 3 hours.

4. A method of claim 3 wherein the block is kept in the tempering chamber for a period of at least 6 hours.

5. A method of any one of the preceding claims wherein the cutting temperature is 2-10 degrees lower than the predetermined degradation temperature.

6. A method of any one of the preceding claims wherein the slicing machine itself is temperature controlled during cutting of the block.

7. A method according to any one of the preceding claims in which the block is a block of tuna.

8. A method of any one of the preceding claims wherein said cryogenic freezing temperature is -49 degrees Celsius or colder.

9. A method of any one of the preceding claims wherein the step of re-freezing said sliced material is carried out dynamically by passing the sliced material through a cryogenic freezing tunnel.

10. A method of any one of the preceding claims wherein the sliced material is packaged directly after the cryogenic re-freezing.

11. Apparatus for preparing sliced fish or sliced meat in accordance with any one of claims 1 to 10, comprising a temperature controlled tempering chamber set at a predetermined temperature, a temperature controlled cutting machine for slicing fish or meat received from the tempering

chamber and a cryogenic freezing arrangement for cryogenically freezing the sliced fish or meat from the cutting machine within a predetermined time.

12. Apparatus of claim 11 wherein said cryogenic freezing arrangement is a continuous freezing conveyor comprising a conveyor and means for spraying the sliced fish or meat with cryogenic material as the sliced fish or meat passes along the conveyor.

13. Apparatus according to claim 11 or 12 which further comprises a packaging machine downstream of the cryogenic freezing arrangement.

14. Apparatus according to any one of claims 11 to 13 which comprises a cryogenic storage chamber for storing fish or meat awaiting tempering and/or for storing sliced fish or meat received from the cryogenic freezing arrangement.

15. Apparatus of claim 14 wherein the cryogenic storage chamber maintains a temperature of below -49 degrees Celsius.

16. Apparatus of any one of claims 11 to 15 wherein the tempering chamber is set at a temperature in the range -2 degrees Celsius to - 8 degrees Celsius.

17. A method of preparing fish, substantially as described

herein with reference to the examples.

18. Apparatus for preparing fish or meat, substantially as described herein with reference to the examples.

Application No: GB 0007746.1
Claims searched: 1-18

Examiner: Peter Trickey
Date of search: 8 March 2001

Patents Act 1977
Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.S): A2B (BMM39), A2D (DEF)

Int Cl (Ed.7): A23B 4/06, 4/07

Other: Online: EPODOC, WPI, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
X	EP 0245033 A1	(Geo. A. Hormel) Figure 6 and page 5 line 12 to page 6 line 22, page 7 line 12 to page 8 line 7, and page 9 line 21 to page 10 line 4	1-5, 8-9
X	JP 010020054 A	(Katayama) WPI abstract accession number 1989-066481 [17]	1, 5, 8, 10

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
		E	Patent document published on or after, but with priority date earlier than, the filing date of this application.
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